Legacy Effects of Summer Green Manure Cover Crops on Irrigated Wheat

Garba et al., 2022 & Lal et al., 2022 Karaj, Iran (2017–2021)

Introduction

This trial built directly on our previous conservation agriculture experiment, focusing on the **carry-over benefits** of green manure cover crops (GMCCs) grown over the summer fallow before irrigated wheat. By comparing plots with and without a summer GMCC phase, we quantified impacts on soil health, wheat yield, grain quality, and economic returns.

1. Experimental Design

- Site: Same Karaj research farm under irrigated wheat rotation.
- Tillage & Beds: Double minimum tillage with 60 cm raised beds maintained throughout.
- Treatments:
    - Control: 45-day summer fallow (mechanical weed control).
    - Legacy GMCC: 60 days of summer cover crop growth, then 30-day fallow.
- Cover-Crop Mix: Fast-growing legumes (cowpea, clover) + grasses (forage millet, sudangrass).
- Wheat Planting: No-till drill into residues in late October.
- Measurements: Soil moisture & temperature; residual soil N; wheat yield & components; grain protein & test weight; pest incidence; input costs.

2. Key Results

2.1 Soil Health Carry-Over

- **Soil Moisture:** 15 % higher moisture at sowing under GMCC plots, boosting early vigour.
- **Residual N:** GMCC mulch contributed an estimated 30 kg N/ha by mineralization at wheat planting.
- **Temperature Buffering:** Soil in GMCC plots warmed more gradually in autumn, enhancing seed germination uniformity.

2.2 Wheat Yield & Quality

Metric	Control (No GMCC)	Legacy GMCC	Change
Grain yield (t/ha)	6.3	7.1	+0.8 (13 %)
Grain protein (%)	12.4	13.1	+0.7
Test weight (kg/hL)	77.5	79.8	+2.3

Metric	Control (No GMCC)	Legacy GMCC	Change
N uptake (kg/ha)	130	155	+25

- Yield rose by 0.8 t/ha under the GMCC legacy, driven by better early growth and nutrient supply.
- Grain protein and test weight improved, reflecting steadier N release and moisture.

2.3 Pest & Disease Regulation

- **Disease Incidence:** Flag leaf rust severity dropped by 20 % in GMCC plots, likely due to a more vigorous canopy and residue-borne antagonists.
- **Weed Pressure:** Post-emergence weed counts in wheat reduced by 35 %, cutting one herbicide pass per season.

2.4 Economic Assessment

- **Input Savings:**
  - Fertilizer: 15 kg/ha less urea required.
  - Herbicide: One fewer application at 600 €/ha.
- **Return on Investment:**
  - Net gain of ~250 € per hectare after accounting for cover-crop seed and planting costs.

3. Recommendations for Farmers

To harness these legacy benefits within a conservation wheat system, progressive farmers should:

- **Integrate Summer GMCCs**
  - Sow legume-grass mixtures immediately after harvest.
  - Aim for 60 days of cover growth, then terminate 30 days before wheat sowing.
- **Residue & Tillage Management**
  - Retain all GMCC residues as surface mulch.
  - Use only disc harrowing; avoid inversion ploughs to protect soil structure.
- **No-Till Wheat Seeding**
  - Employ a no-till drill that places seed directly into the residue-covered raised beds.
  - Calibrate seeder to ensure 4 cm sowing depth and 15 cm row spacing.
- **Optimized Irrigation & Nutrition**

    - Delay first irrigation until tillering; monitor soil moisture sensors.
    - Reduce synthetic N application by 15–20 kg/ha, relying on GMCC mineralization.
- **Monitoring & Adaptive Management**
    - Track soil moisture, N levels, and canopy health through the season.
    - Adjust cover-crop species ratios and sowing windows based on annual weather forecasts.

4. Expected Benefits

By embedding a summer GMCC phase into your irrigated wheat rotation, you will achieve:

- Enhanced early-season soil moisture and nutrient availability.
- Consistent yield increases of 10–15 % alongside improved grain quality.
- Lower disease and weed pressure, cutting pesticide costs.
- Positive net economic returns from reduced inputs and higher marketable grain.
- Strengthened soil structure and long-term resilience under climate variability.

These legacy effects form a cornerstone of regenerative conservation agriculture—boosting profitability while regenerating the resource base for future seasons.